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NON-WOVEN PRODUCT

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No Drawing. Continuation of abandoned application Ser. No. 881,268, Dec. 1, 1969. This application June 12, 1972, Ser. No. 261,770

Int. Cl. B32b 5/06

U.S. Cl. 161—81 2 Claims

ABSTRACT OF THE DISCLOSURE

A non-woven nylon article, particularly useful as a carpet backing for either tufted and/or needle-punched carpets, in its preferred form comprising a non-woven nylon mat and an open filament yarn base bonded by a combination of needle-punching and selective heat treatment, and a binder, as described hereinafter.

This is a continuation of application Ser. No. 881,268, filed Dec. 1, 1969, now abandoned.

BACKGROUND AND PRIOR ART

The field of non-wovens is now replete with publications on all aspects of product, product usage, and manufacture. The principles on which production of non-wovens is based are relatively simple, but their application in practice is an extremely complex art, one in fact which has become highly developed in a relatively few years. The background and prior art publications relative to this invention generally deal with disclosures concerning variations in web production, as by use of carding equipment, cross-laying or overlapping several web layers thus formed, continuous filament lay-down on a moving conveyor, random deposition by the well known Rando-Webber machine, etc. Similarly, much is published concerning various bonding processes by chemical and/or heat means, binders, fillers, and other non-woven manipulations and components. A good summary of non-woven development is set out in "The Development of Non-Wovvn Fabrics" by A. R. Smith, Chemistry and Industry, Dec. 28, 1968, which includes some 77 references to articles and patents.

Previous publications of particular pertinence to the present invention are U.S. Pat. 3,394,043, disclosing a non-woven polypropylene carpet backing marketed under the trademark "Locktuft" and also U.S. Pat. 3,286,007, disclosing a polypropylene non-woven carpet backing marketed under the trademark "Prime Bak." Polypropylene products of this type have been used considerably, due primarily to economic reasons and even though lacking certain physical property attributes due to the nature of polypropylene. For example, polypropylene, although relatively inexpensive, is physically incapable of taking many of the more inexpensive dyes and the commonly used cheaper lubricants; therefore, it is necessary to utilize polysiloxane or silicone base lubricants, and even when these materials are used the lubricated web will not be compatible with a continuous dyebath operation and has a low receptivity for most adhesives. Further, the polypropylene webs are incompatibly heat sensitive with hot melt backing systems of today.

SUMMARY AND OBJECTS

The present invention is concerned with improving carpet backings, particularly with respect to heat sensitivity, receptivity to adhesives, dyeing characteristics and to weight, strength, durability, and the like. This is accomplished by employing nylon in a novel combination of material and by combining the materials in a particular, novel manner. More specifically, this invention provides, for the time, a carpet backing comprised entirely or almost entirely of nylon, but which is economical. The nylon backing is much less heat sensitive and can therefore be tufted at higher needle speeds, will readily accept inexpensive lubricants such as alkylated fatty acids, will readily accept a wide range of adhesives, related soaps and/or surfactants, and has excellent dyeing characteristics as well as other advantages over previously known carpet backings, with or without nylon included therein.

These objects and others are achieved primarily from a novel selection of economic materials, which may include the use of garnetted nylon fibers to a certain extent, within certain appropriate size, weight, and denier ranges. The materials are combined in a strong, yet light weight and flexible unit which itself affords advantages, and which has further advantages in alleviating or solving problems of backing and carpet manufacture inherent with prior art backings.

A principal object of the invention is, therefore, to provide a novel non-woven carpet backing having a relatively low density and good mechanical strength comprising a nylon web and an open filament yarn base, bonded by a combination of needle-punching and selective heating, and in the preferred embodiments further comprising a small amount of synthetic latex, acrylic or other binders.

Another object is to provide improved carpet backing articles comprised in part of matrix filaments or fibers blended with the other substrate materials, matrix filaments or fibers referring to filamentary material containing at least two different fiber forming polymeric materials having differing melting points, the lower melting component thereof forming a matrix in which the other is dispersed in microfibrillar form. A further object is to provide a non-woven web for a carpet backing, comprised of nylon fibers blended with virgin staple fibers as will be described.

Other objects and advantages will be described and will become apparent to those skilled in this art from the appended claims and following description of the best mode of carrying out the invention, and examples thereof.

DESCRIPTION

In acoordance with the present invention, the product is composed of non-woven substrate comprised of nylon staple fibers having a denier of 3 to 15 which is reinforced by either a parallel layer of continuous filament nylon of 100 to 200 denier or a woven scrim. The non-woven substrate may be needle-punched both before and after the reinforcement elements are added to the construction thereof. The reinforced structure is consolidated by the combined processes of needle-punching and heat setting under critically selected conditions. The heat setting may be accomplished by calendering and/or embossing between opposed pressure rolls or platens, or by other types of heat sources.

The preferred carpet backing of this invention is a non-woven web or mat produced by random air laid staple fibers, or carded or garnetted and lapped web or webs to form a substrate. The substrate thus formed is needle-punched into a parallel laid nylon filament scrim yarn interposed on one side of the substrate or between web layers thereof. It is preferable to provide the latter construction although a single web on one side of the scrim will also produce a good product. After needle-punch bonding together, the mat and scrim are then heat treated, as by calendering on an embossing calender, or otherwise subjected to point fusion, to further bond certain discrete areas while leaving a large proportion of the fibers in a relatively free state. The mat and scrim product

thus produced has a finished weight of 2.5–4.5 ounces per square yard, 3.2–4.0 preferably, which is considerably less weight than the above-mentioned polypropylene backings. Finally, the product is strengthened and stabilized with a small proportionate amount of synthetic adhesive by spray bonding, drying and heat setting under controlled conditions.

The nylon mat-nylon scrim combination and the combination of needle punching and calendering result in a product which is relatively insensitive to heat (350° F.), as compared to the polypropylene backing (230° F.), and thus can be utilized with the new hot melt backing systems. In dyeing operations the nylon backing readily accepts the commonly used dyes and thereby avoids "grinning" problems frequently encountered with other natural or synthetic materials of different colors that resist dyes or takes on different shades than the tufting. Also, its heat sensitivity and porosity permits the backing to be subjected to faster and more uniform drying temperature while at the same time air can pass through the web (after tufting or needling). And, in addition to the normal advantages of non-wovens over the available wovens, the carpet backing of this invention will not ravel at the edges and will have a more dimensionally stabilized construction than either available wovens or non-wovens.

The low weight web material, being produced at high speeds of up to about 30 feet per minute or more, for example, may be composed of staple fibers, or blends thereof, staple fibers plus producer textured waste yarns, or merely blends of producer textured waste yarns reprocessed by garnetting. The nylon staple fibers should be within the range of 3–15 denier, although it is preferred that a major portion be in the range of 5 to 8. The preferred staple fiber length is from 2¾ to 4½ inches with the higher denier staple being of longer length generally.

Tests have proven that the most critical factors involved in producing the carpet backing of this invention reside in the appropriate selection of denier and staple. Thus, the denier employed for the nylon web should be such that at least 50 percent by weight of the web be of 5 to 8 denier, and more specifically, in the following approximate ranges:

Denier:	Percentage
3–4	0–25
5–8	50–100
8–15	0–25

The reinforcing scrim may be woven or parallel laid nylon filament (in the machine direction), preferably ranging from 90 to 120 denier, 10 ends per inch of width.

The following specific example of the preferred embodiment hereof is illustrative of the invention. Nylon 6 staple fiber of 2¾ inches length, 50 percent 15 denier per filament and 50 percent 6 denier per filament were blended and opened. A tendem weighing device was utilized to balance out fiber weight for the web.

Webs produced by a carding machine were crosslapped at approximately 85° to give a 2.5 ounce per square yard mat and a nylon scrim was inserted between upper and lower webs. Actually, in the preferred embodiment the scrim was a continuous yarn laid into the center of the material in the machine direction and weighed 0.15 ounce per square yard, a total of 100 denier-10 ends per inch, giving a total mat and scrim weight of 2.65 ounces per square yard. Upon completion of web laying and scrim insertion, the material is lightly compressed to reduce its loftiness. As an alternative of equal quality, a woven nylon scrim, weighing between 0.12 and 0.35 ounce per square yard as, for example, 5 by 5 or 6 by 6 count, or 6 warp by 2–3 fill, may be used.

To avoid setting up lines of stress in the final product it is preferable to employ a random, non-uniform needle pattern. The mat fed through the needle loom under low tension was penetrated ⅝ inch, 200 punches per minute, needle 15 by 18 by 36 by 3½ round barb. The penetration count for each of two passes was 200 per square inch.

The embossing is performed on both sides of the needled mat preferably, but not necessarily, by at least two different patterns. Suitable patterns are, for example, pigskin, scroll, bubble, alligator and the like. Thus a broad scroll pattern was used on the face or upper side of the mat to assure fusion and heat bonding on limited surface areas and within the mat, while the smaller pigskin pattern promoted surface bonding only on the back side, the net result being an intermittent discontinuous bonding of the needled webs and scrim. A four roll calender was used, with two pairs of steel engraved rolls running against two firm fiber rolls. The embossed patterns will therefore appear predominately on one side of the mat, and the other being composed of freer fibers resulting in an article that can be very easily tufted, dyed and dried. The temperature range for calendering nylon 6 (polycaproamide) is preferably about 400° to 420° F.; 410° F.±4° F. (face side) and 405°F.±4° F. (back side) producing the best fusion bonding while operating at 400 to 700 pounds per square inch, preferably 600. Nylon 6,6 (polyhexamethylene adipamide) requires temperatures approximately 45° F. higher.

As a final bonding step, it is preferable to apply a limited amount of adhesive synthetic binder (0.5 ounce per square yard). The latter is applied by spray to the more highly bonded back side of the mat to preserve the advantages of the freer fiber side, yet contribute the bonding properties desired, i.e., the binder will penetrate into the mat and promote dimensional stability and strength of the final product. It is then dried in an infrared oven and cured in a festoon type air connection oven at 350° F. for five minutes to completely cure the latex. The adhesive constituted 12 to 20 percent of the final product weight.

Immediately after the adhesive is applied to the heat fused mat, the latter is passed through a heating zone (about 150° F.) for about 45 seconds to drive off excess moisture and produce preliminary heat setting of the adhesive. Thereafter, the mat is exposed to the curing zone above mentioned. Next a lubricant spray is applied to reduce the metal-to-fiber friction during later carpet manufacturing procedures such as tufting and needlepunching. The lubricant constitutes an addition of approximately 1 percent more weight to the carpet backing, and must be of a type compatible with the carpet dye bath. Lubricants of this type are known to the art.

As mentioned above, the advantages of the described non-woven carpet backing are derived from its nylon composition and the manner in which it is assembled. It is, of course, contemplated that minor amounts of other synthetic or naturally occurring fiber and fiber-like materials can be introduced into the web or scrim without departing from the essence of this invention. Similarly, additives such as alkalis or other synthetic stabilizers, wetting agents, dispersing agents, antioxidants, plasticizers, pest repellents and the like may be added. More particularly, as another embodiment of this invention the inclusion of a small proportion (3 to 25 percent by weight) of a matrix staple fiber 2¾ to 4 inches long is contemplated and within approximately the same denier ranges as given above, but preferably slightly higher, e.g., 5 to 15.

As used herein, matrix-type fibers or filaments means filament made by inclusion of at least one polymeric material in the form of discontinuous fibrils in a matrix of another, the two materials having substantially different melt temperatures such that fibrous constructions composed thereof can be bonded preferably, but not necessarily, by application of heat below the melt temperature of one and equal to or above that of the other, the entire filament composition or any component thereof optionally including any secondary material compatible with the

bonding process and end utility of the product as a whole, such as antioxidants and other stabilizing agents, reinforcing particles, fillers, adhesion promoting agents, fluorescent materials, dispersing agents, and others useful in polymerization, extruding, spinning, fabric forming and shaping, heat setting and product finishing techniques. If desired, inorganic materials such as metal whiskers, fiberglas fibrils, asbestos particles and the like may be incorporated for conductive and/or reinforcement purposes.

The preferred matrix fibers useful herein are comprised of a homogeneous mixture of two different polymeric materials, the lower melting material being nylon 6 and foming a matrix in which the higher melting material, preferably polyethylene terephthalate, is dispersed throughout in the form of discontinuous microfibers. Although various polymeric materials are mixed together, they need not be entirely intermiscible due to their physical properties and/or the mixing technique employed to disperse the higher melting component in the matrix material for forming microfibers. Thus micro-sized globules or fibrils are usually initially produced in the matrix, which when spun or drawn produce the desired microfibrillar dispersion in the lower melting matrix material. As in the case with any of the above-mentioned fibers, the component filaments may be round, trilobal, elliptical, or any other cross-sectional shape.

The principal advantage offered by employing matrix-filaments, wherein the matrix is composed of a lower melting polymer than the dispersed component, is their ability to bond by heating without flowing. Thus, a nylon matrix fiber functions essentially as nylon fiber in the carpet backing thereby contributing improved strength, tear and durability.

Matrix filaments have the ability to bond to each other, and to other filaments, in a manner which does not cause significant flow or cross-sectional disfiguration, thereby setting up conditions for bonding systems that promote fiber orientation and strength and yet which admit controllable physical properties such as porosity, permeability, appearance, texture, etc.

Further, the matrix fibers effectively bond under the heat binder conditions preferred for this invention, such bonding being by localized fusion partial or complete, of individual portions of the fibers. Such fusion may be brought about by spark discharge through the web or the application of heat to highly localized, mechanically isolated portions of the web as by embossing described above.

As to chemical make-up, the matrix filaments pertinent to this invention are prepared from a polyester-polyamide combination. The compositions contain 50 to 90 parts by weight nylon 6 and 50 to 10 parts by weight of a polyester microfibrillar dispersion.

The following example is illustrative of the use of matrix fiber in this invention. The matrix filaments were produced in accordance with the formulation of Example 1 in U.S. Pat. 3,369,057, i.e., granular polyethylene terephthalate polymer was used, melting about 255° C. (DTA) and about 265° C. (optical), having density (when amorphous) of about 1.33 grams per cc. at 23° C. and about 1.38 grams per cc. in the form of drawn filament, having reduced viscosity of about 0.85 and having T_G about 65° C.

The polyester (30 parts) is mixed with 70 parts of granular polycaproamide having reduced viscosity about 1.04, T_G about 35° C. and density about 1.14 grams per cc. at 23° C. Amine groups in this polycaproamide had been blocked by reaction with sebacic acid, bringing the amine group analyses thereof to 11 milliequivalents of NH_2 groups per kilogram of polymer, This polycaproamide contained as heat stabilizer 50 p.p.m. copper as cupric acetate.

The mixture of polyamide and polyester granules is blended in a double cone blender for 1 hour. The granular blend is dried to a moisture content of no more than 0.01 percent; then melted at 285° C. in a 3½ inch diameter screw extruder operated at a rotational speed of about 39 r.p.m. to produce a pressure of 3,000 p.s.i.g. at the outlet. A dry nitrogen atmosphere is used to protect the blend against absorbing moisture. Residence time in the extruder was 8 minutes.

The molten mixture thereby obtained should have a melt viscosity of about approximately 2,000 poises at 285° C. The polyester will be uniformly distributed throughout and have average particle diameter of about 2 microns. The latter can be tested by cooling and solidifying a sample of the melt, leaching out the polyamide component with formic acid and examining the residual polyester material.

The polymer blend thus produced is hereafter referred to by code designation as a nylon/polyester matrix fiber. The latter is formed into a 10 denier fiber and cut into 3½ inch staple. A mixture of 20 percent by weight nylon/polyester matrix fiber, 80 percent nylon 6, 3 inch, 6 denier staple was carded, deposited in cross-lapped webs to produce a 3.0 ounce per square yard mat in the manner described above and combined with a 0.2 ounce per square yard parallel laid scrim. The mat scrim is then fed through a needle loom under low tension, again in the manner described above. Thereafter, embossing is carried out by calendering with a broad scroll pattern on the upper surface and a pigskin pattern on the bottom surface, at slightly higher temperatures than with only nylon, i.e., at 410° F. to 430° F., preferably 422° F. The matrix fiber being present in a significant amount, up to 25 percent, and the higher embossing, will result in point fusion of the matrix material, setting up a relatively firm, dimensionally stable network of fibers bonded to each other and to the companion nylon fibers and scrim within the mat.

After the needle-punch and embossing steps synthetic latex is applied by spraying the bottom side and the backing dried and cured, all in the manner described above.

In another embodiment a 5 x 5 nylon scrim is used, interposed between layers of a mat comprised of 8 percent nylon/polyester matrix fiber staple 10 denier 3½ inches long, and 92 percent nylon 6, 3 inches long, 6 denier, the mat being 2.8 ounces per square yard and the scrim being 0.2 ounce per square yard. All other process conditions and materials being described above.

We claim:

1. A synthetic carpet backing suitable for use in tufted and needle punched carpets, comprising a sandwich of:

(a) first and second nonwoven webs formed from nylon staple, said nylon staple having a staple length of from 2¾ to 4½ inches and a denier distribution as follows:

Denier:	Percentage
3–4	0–25
5–8	50–100
8–15	0–25

(b) yarn base interposed between said first and second webs, and comprising a machine direction continuously laid down layer of nylon monofilament ranging from 90–260 denier and 5 to 15 ends per inch;

(c) said webs being randomly, nonuniformly needle punched, and fusion heat bonded primarily on the outer surface of both webs and intermittently on limited areas of said first web within said backing to produce an intermittent discontinuous bonding of the needled webs and base;

(d) said backing containing an additional 12–20 weight percent adhesive synthetic binder only on said first web to preserve the advantage of the freer fibers of said second web.

2. A synthetic carpet backing suitable for use in tufted and needle punched carpets, comprising a sandwich of:

(a) first and second nonwoven webs formed from nylon staple, said nylon staple having a staple length of from 2¾ to 4½ inches and a denier distribution as follows:

Denier:	Percentage
3–4	0–25
5–8	58–100
8–15	0–25

(b) yarn base interposed between said first and second webs, and comprising a woven nylon scrim weighing between 0.12 and 0.35 ounce per square yard;

(c) said webs being randomly, nonuniformly needle punched, and fusion heat bonded primarily on the outer surfaces of both webs and intermittently on limited areas of said first web within said backing to produce an intermittent discontinuous bonding of the needled webs and base;

(d) said backing containing an additional 12–20 weight percent adhesive synthetic binder only on said first web to preserve the advantages of the freer fibers of said second web.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,834,978 Dated September 10, 1974

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It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 7, line 8, under heading "Percentage", "58-100" should read --50-100--.

Signed and sealed this 17th day of December 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
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